I. SOIL FAUNA :

Habitat Classification Using Soil Fauna Populations

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INTRODUCTION

The soil system is inhabited by a great variety of soil animals which, because they are more sedentary than the above ground animals, are more likely to reflect by their community structure the prevailing environmental conditions of the habitat . Because the soil is a secluded environment, some elements of the soil fauna may remain alive and active long after removal of the envvironmental conditions that helped in the establishment of those elements, when those conditions were prevailing. This is why soil fauna are sometimes described as " conservative". The energy flux and material cycling in the soil being much slower than on the surface, even if some plants disappear, their litter and the soil organic matter produced from the decomposition of that litter, and retaining its peculiarities, will remain in the soil for some time. The soil itself, including the dependent soil animals, will remain structurally faithful to the old vegetation cover .

Each soil type , and hence each habitat , has its own characteristic community of soil fauna, a fact which was first used for soil diagnostic purposes by Ghilarov (1956) and Volz (1962). Changes in soil functioning , whether natural or provoked by man-induced disturbances, result in subsequent changes in the composition of the community of soil fauna, that could be easily detected with appropriate statistical techniques (Ghabbour 1991). Local variations in space and time, and their impacts on soil fauna communities, have been the subject of a number of recent studies. The effects of human activity, in natural as well as in agro-ecosystems, have also been studied (de Molenaar, 1974, Ghilarov1975, Ghilarov and Pokzrzhevsky 1984, Ghabbour and Shakir 1981, Ryszkowski 1985). These studies revealed that populations and groups of soil animals are remarkable for their stability and resilience, as well as their persistence, even during adverse changes occurring within a severely perturbed ecosystem. Some individuals always remain hiding either in deeper soil layers, crevices, or adjacent micro-island habitats. Moreover, natural or man-induced physico chemical properties in the habitat (temperature, moisture, agrochemicals, etc.), are more diluted in the soil than on the surface.

CHOICE OF INDICATOR SPECIES

Larger sized soil invertebrates (macro-invertebrates) have been found to be a better option for habitat classification than micro-invertebrates such as Protozoa, the former can be found within a fairly wide range of ecological conditions, with different species belonging to each group in different habitats (a larger biodiversity). The habitat of these species is the soil medium itself rather than films of moisture or minute interstices among soil particles. Habitats of many species of macro-invertebrates are fairly well known, and their populations occur in fairly large numbers for comparisons to be meaningful both in time and space. We may divide these species (or taxa), according to their usefulness as indicators, or as indicator groups, into three categories :

1- species characteristic of a very limited number of habitats, or only of one habitat,
2- species (or taxa) characteristic of a wider range of habitat types, and
3- species not particularly associated with any special habitat type (ubiquitous species).

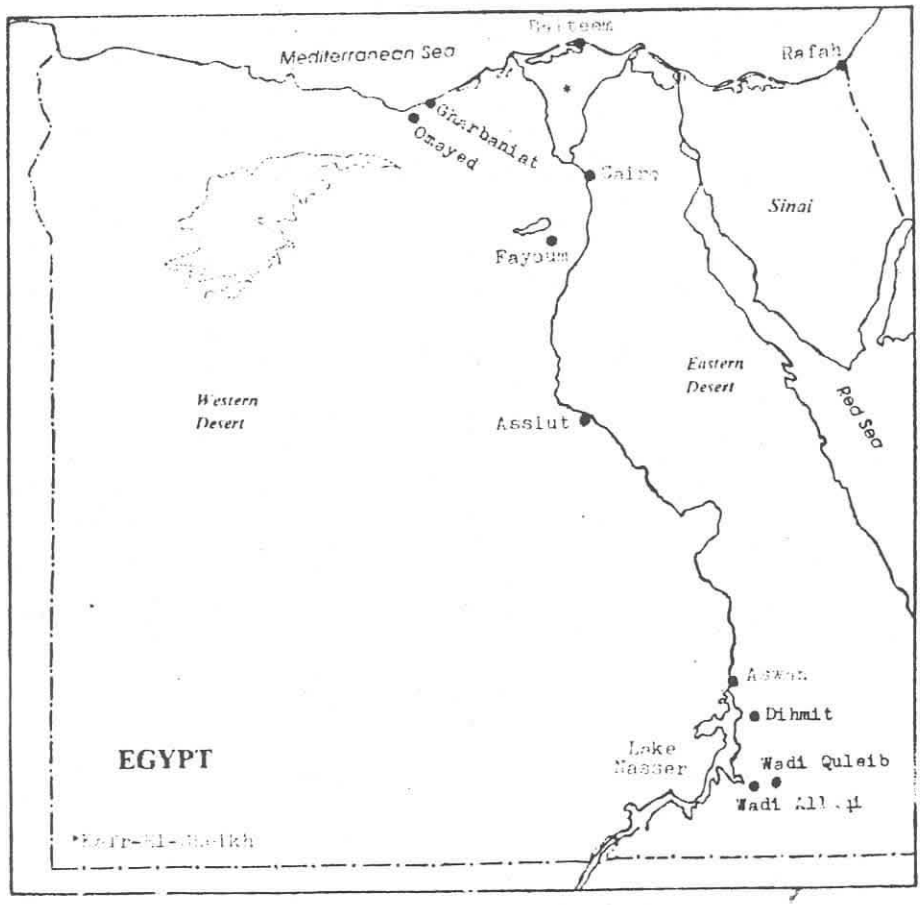
Each of these three categories has its own merit in habitat classification. The first one is of course valuable for identifying a particular set of environmental conditions narrowly characteristic of a given environmental situation in a given habitat, which may however extend over a large area, or of a limited number of closely similar habitats under very similar environmental conditions. The

second category indicates the continuity of certain habitat characteristics along an environmental gradient.The third category is useful in indicating the more generalized character of those habitats, and the environmental conditions they may have in common.While interest must be given to each of these categories in its own right, it is more interesting though, to study the entire community of soil fauna. as this will reveal more important and more significant and profound aspects of the habitats being classified and compared (Ghabbour 1988)

MATERIAL AND METHODS

HABITATS OF THE PRESENT STUDY

The present study gives a summing-up of some of the more pertinent analyses that were carried out for habitat classification in Egypt, using soil fauna populations as indicators (Ghabbour 1986, 1988, El-Shishiny and Ghabbour 1988). These studies include habitats in the northwestern coastal desert (the Mariut region west of Alexandria), where several types were studied (Hegazi et al. 1981, Ghabbour et al. 1985), the area of Balteem, on the coast of the northern Nile Delta (Mikhail 1987), the area of Rafah (northeastern coast of the Sinai Peninsula , present study), Wadi Assiuty in the Eastern Desert, Upper Egypt (Ali et al. 1985), and sites from the southeastern desert of Egypt in the Wadi Allaqi area near the shores of Lake Nasser (present study). Very few studies on soil fauna communities in the agro-ecosystem habitats of the Nile Valley and Delta were found to be suitable for the present classification analysis. We include a study of soil fauna in an onion field at Giza (near Cairo) by El-Kifl (1958), a study by Tadros (1974) at Kafr El Sheikh, a study on Fayoum (Etsa region), by Zedan et al. (1991), and a study of soil nematodes in the Delta (Abd El Massih et al. 1982).



Map of sites representing habitats studied in the present survey.

METHODS OF SAMPLING SOIL FAUNA

1- The Sieving Method

This method was described earlier by Ghabbour et al. (1977). Briefly, it consists of digging the soil under the canopy of the shrub selected for sampling and passing it through a 1-mm sieve, untill animals and litter are no longer obtained. A few extra sievings are passed through to ensure that the soil core under the canopy has been completely sampled.The diameter of the shrubs and maximum depth attained are then recorded. This method was used to collect soil animals from under: **Lygos raetam,Thymelaea hirsuta, Lycium shawii**, and **Jasonia candicans** shrubs at Gharbaniat (Ghabbour et al. 1977 and 1985): **Anabasis articulata, T.hirsuta** shrubs at Mariut frontal plain (Ghabbour and Shakir 1980 and Ghabbour et al. 1985); fig orchard in the littoral sand dunes at Omayed (Ghabbour et al. 1985); **Alhagi maurorum** and **Silene succulenta** shrubs of the sandy soils of northern Delta at Balteem (Mikhail 1987); and **A. articulata** and **T. hirsuta** shrubs under different rates of grazing pressure at the Omayed Biosphere Reserve (Cancela da Fonseca et al. 1984).

2- The Hand Sorting Method

Samples of soil animals were collected from each of dry-farming field crops (Ghabbour et al. 1985); and irrigated field crops (Ghabbour and Shakir 1982 b and Ghabbour et al. 1985). Ten soil quadrats (50 x 50 x 50 cm deep) were randomly collected from each of the mentioned farming systems. Hand picking of fauna was made carefully from whole quadrats on white cloth or paper sheet and animals preserved in 70 % ethanol.

3- The Pitfall Trap Method

The trap was laid in the soil by digging a hole in the ground, deep enough to take the whole tin can or jar. It is important that the mouth of the container is level with the ground surface so that the animals are unaware of the trap, and drop into it rather than walk around it. Formalin solution (4%) with detergent was placed in the bottom of the trap (since alcohol evaporates rapidly) in order to cause rapid death by drowning and thus prevent animals from eating each other, or keeping them preoccupied with trying to get out. The role of the detergent is to minimize surface tension of water and cause rapid sinking of such animals . Pitfall traps were placed in such areas at dusk on one day, they were kept open during night and the animals were collected the next day. This method was used for surveying surface active soil animals at each of: Wadi Assiuty area (Ali et al . 1985); Fayoum (Zedan et al. 1991). This method was also used in Rafah (Northern Sinai), in Wadi Allaqi, Wadi Quleib, and Dihmit farm in the south eastern desert of Aswan (present study).

4- The Tullgren Funnel Method

This method was used for collecting soil animals from each of: onion fields at Giza (El-Kifl 1958); rice straw and dried clover at Kafr-El-Sheikh (Tadros 1974); and from dryfarming olive and irrigated olive and vineyard at Burg El-Arab (Hegazi et al. 1981). Soil cores were taken from each of the mentioned farming systems, placed on gauze fixed on the walls of a funnel . An electric bulb was used as a source of heat . Animals escape away from excessive heating and fall into a plastic or glass container, containing 70% ethanol , placed below the funnel.

STATISTICAL METHODS

The statistical methods used in the present analyses for habitat classification are correspon-

dence analysis (CA) and ascending hierarchic classification (AHC). Information about these methods can be found in some of the more recent publications on the subject (Roux 1985, Digby and Kempton 1987, Jongman et al. 1987, Ludwig and Reynolds 1988, Tomassone et al. 1988, Escofier and Pages 1990 and Cibois 1991). The computer calculations of CA and AHC were carried out at Cairo University using DATAVISION programme 1.2 (Roux 1987) developed for APPLE IIe in BASIC, and allowing for the application of the disjunctive coding method. This method comprises the categorization of data into groups or intervals of different levels. The number of categories is variable as well as the border limits, as is desired . Disjunctive coding is a useful tool when dealing with different units and kinds of environmental conditions. This technique was used prior to the application of CA and AHC.

RESULTS

The Mariut Region, west of Alexandria

The Mariut region is a strip of land about 100 km long and 30 km wide west of Alexandria, on the Mediterranean coast, with about 150 mm / year rainfall, decreasing sharply inland. Soils are calcareous clay loam or sandy loam with admixtures of siliceous sands. The landscape is dominated by four prominent limestone ridges running parallel to the coast and enclosing longitudinal plains (depressions). The littoral sand dunes (First Ridge) are sites for hunting wildlife (quail) or for limited fig cultivation. The depression between the First and Second Ridges is used mainly for dry-farmed barley and fig cultivation. The depression between the Third and Fourth Ridges is fairly wide and supports both dry-farmed olive cultivation in favoured sites and free-grazing of sheep and goats on degraded pasture . Some areas in this depression were reclaimed and are irrigated by Nile water. Sites of the Mariut region fall into four main categories: Littoral sand dune (7) , free - grazing land (7), rain-fed agriculture (6), and irrigated farms (3).

Fig. (1) shows results of the application of CA and AHC methods to data of Table (1). 32% of the total variance is associated with the first (horizontal) axis and 20% with the second (vertical) one. Here it is clear that the four main types of ecosystems are appreciably separated on the first axis. The 7 littoral dune sites are very closely grouped on the left hand side of this axis. They are more or less characterized by: Pseudoscorpiones, **Scolopendra**, antlions, Dictyoptera, Scarabaeidae and Curculionidae. On the other hand, the 7 free-grazing sites are distributed as a transitional group between the former and the low-intensity rain-fed farms (barley, fig and almond). The free-grazing sites seem to be characterized by: scorpions, Diptera, Tenebrionidae, Galeodidae, Thysanura, snails, Lepidoptera and Carabidae . A group of 4 taxa composed of isopods, spiders, Formicidae and other minor groups of Coleoptera and Hymenoptera, constitute a transitional fauna leading to rain-fed and irrigated sites. The two olive orchards are in turn characterized by a group of 4 taxa: Heteroptera, ticks, Geophilomorpha and Homoptera. Finally, the irrigated farms are characterized by three groups: earthworms, Orthoptera and Dermaptera.

In order to illustrate the effect of some environmental factors (Table 2) on the distribution of soil fauna groups of the Western coastal desert, these factors are classified by disjunctive coding into 3 categories, except phosphorus which is classified into two classes, the upper limits of these categories are shown in Table (2). Data of soil fauna groups of Table (1) were then distributed among these categories. Fig. (2) shows results of the application of CA and AHC methods to data of Tables (1) and (2) after disjunctive coding method. 78% of the total variance is associated with

Table (1) Population density of soil mesofauna (PD / m ^{2}) in the 23 sites studied in the Mariut regoin, west of Alexandria. All figures are multiplie by 100.

Taxa:		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
earthworms	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	243	24	0	64	0	2863	200	1392
snails	B	0	0	0	0	0	0	0	3	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Isopoda	C	267	537	74	104	116	33	29	70	28	36	19	9	67	368	575	40	152	26	0	1174	73	339	62
spiders	D	29	27	30	39	15	13	85	31	38	6	23	5	42	124	31	20	56	51	98	108	193	193	336
scorpions	E	0	0	0	0	0	0	0	0	4	4	4	4	19	4	0	0	0	0	0	0	0	0	0
Galeodidae	F	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
pseudoscorpion	G	5	7	1	26	0	8	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0
ticks	H	0	0	0	0	0	0	0	0	0	0	0	0	0	12	7	0	0	0	8	0	0	0	0
Geophilomorpha	I	2	11	3	2	0	0	19	0	0	0	0	0	0	0	0	0	0	0	24	20	0	0	0
Scolopendra sp	J	6	4	2	0	4	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Thysanura	K	0	0	0	0	0	0	0	0	0	0	0	0	0	24	7	0	0	15	0	0	0	0	0
Orthoptera	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	10	45	144	988
Dictyoptera	M	790	1297	297	1450	632	1429	1458	649	970	399	884	255	519	1156	152	108	976	44	0	0	0	7	0
Dermaptera	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	58
Heteroptera	O	2	44	41	132	7	4	21	4	7	0	14	7	9	256	17	41	24	0	328	392	130	31	0
Homoptera	P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	486	50	0	0	0
antlions	O	71	133	51	313	59	71	102	6	74	14	96	9	114	338	0	0	256	3	0	0	0	0	0
Formicidae	R	8	111	11	26	9	15	14	459	511	2	28	750	245	330	18	60	936	319	118	392	969	4013	636
Other Hymenopter	S	1	6	5	4	0	0	0	4	11	5	8	0	0	0	0	0	8	71	24	50	0	10	0
Diptera	T	17	27	14	37	49	36	65	8	10	5	14	5	32	144	112	38	160	8	10	0	0	8	44
Lepidoptera	U	16	41	0	12	21	10	41	7	12	2	30	5	9	60	21	23	24	8	0	78	88	46	40
Tenebrionidae	V	278	1070	204	905	326	531	364	98	328	53	170	157	368	1542	1702	397	1760	326	188	222	24	94	534
Scarabaeidae	W	586	1878	608	694	130	228	159	46	71	30	39	22	19	908	638	99	376	109	8	44	16	7	60
Carabidae	X	18	36	11	15	4	8	11	31	72	19	74	94	59	130	9	28	56	8	28	18	113	62	80
Curculionidae	Y	35	124	30	86	45	20	38	3	18	10	16	29	22	0	23	40	104	0	0	0	0	0	0
Others	Z	0	0	0	0	0	0	0	0	0	0	0	0	0	280	78	20	48	8	50	70	48	0	98

Littoral sand dune sites : 1 - **Lygos raetam**, Gharbaniat, windward,. 2 - **Lygos raetam**, Gharbaniat, laeward, 3 - **Thymelaea hirsuta**, Gharbaniet,windward, 4 - **Thymelaea hirsuta**, Gharbaniat, leeward, 5 - **Lycium shawii**, Gharbaniat, windward, 6 - **Lycium shawii**, Gharbaniat,leeward , 7 - **Jasonia candicans**, Gharbaniat; Free - grazing sites : 8 - **Anabasis articulata**, North Omayed, windward, 9 - **Anabasis articulata**, North Omayed, leeward, 10 - **Thymelaea hirsuta**,Omayed Centre, windward, 11 - **Thymelaea hirsuta**, Omayed Centre, leeward , 12 - **Anabasis articulata**, South Omayed, windward, 13 - **Anabasis articulata, south** Omayed, leeward, 14 - **Thymelaea hirsuta**, South Gharbaniat; Dry-farmed sites : 15 - fig, Omayed, littoral sand dunes.16 - fig, Gharbaniat, depression between First and Second Ridges, 17 - almond, Gharbaniat, depression between First and Second Ridges, 18 - barley, Gharbaniat, depression between First and Second Ridges, 19 - olive,5 Km east of Burg- El - Arab town, 20 - olive, Burg- El - Arab town; Irrigated sites : 21 - old vineyard, south Gharbaniat . 22 - young vineyard, South Gharbaniat. 23 - irrigated rotation field crops, Burg-El-Arab .

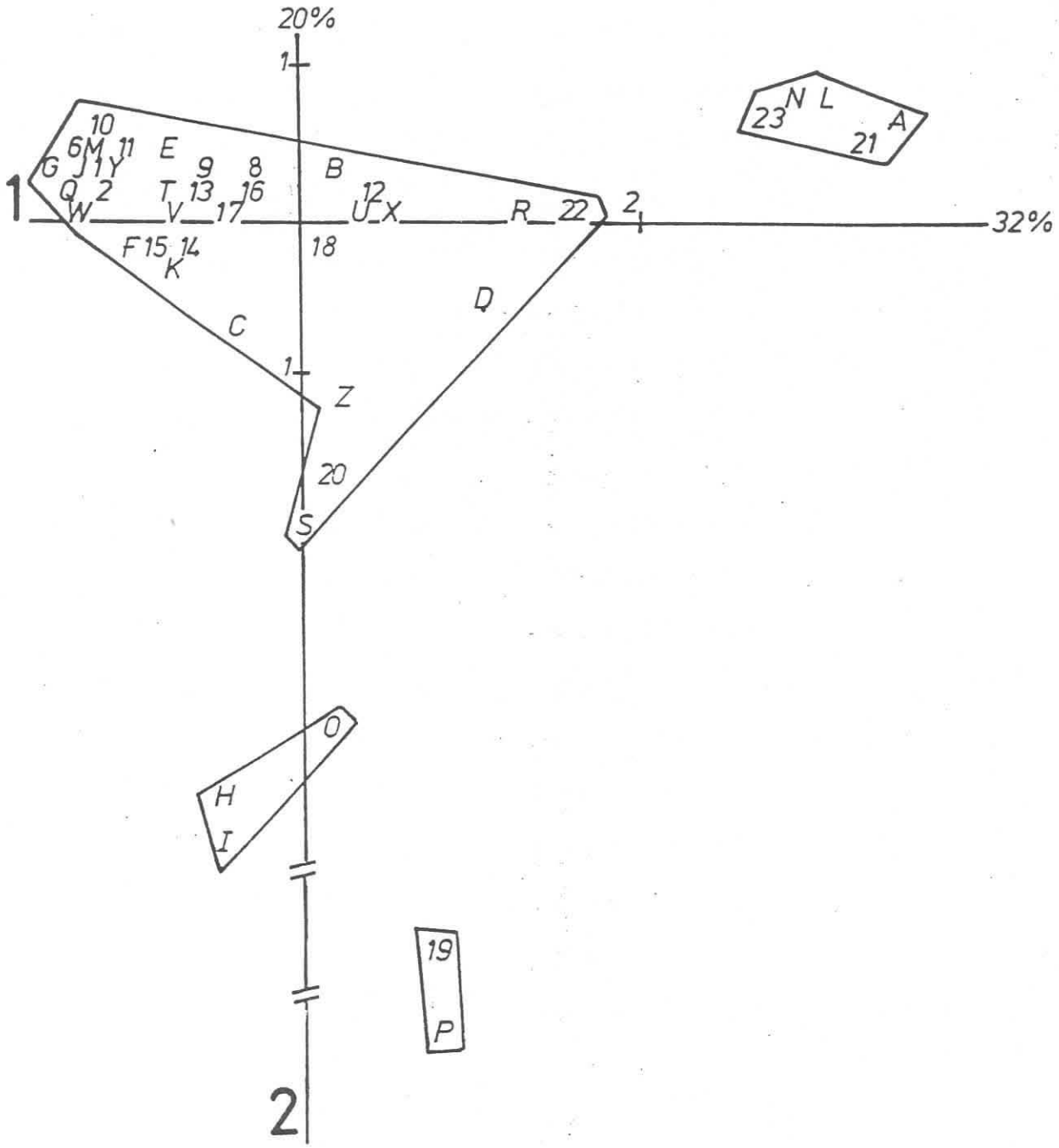


Fig. (1) Graphic representation of the application of CA and AHC methods to data of Table (1). Symboles of sites (1-23) and species (A-Z) are as shown in Table (1). Points 5&7 are with 1,3 & 4 with 2.

Table (2) Percentages of sand, silt, clay, soil moisture, organic matter, Calcium carbonate, nitrogen and phosphorus, each as mgm/100 gm of soil. The upper limits of each of lower (L), medium (M), and higher (H) classes of these factors are shown at the end of the table.

Site No	Sand	Silt	Clay	Soil Moisture	Organic Matter	N mg/100g	p mg/10^0g	Ca CO3
1	88.7	10.6	.6	2.78	.25	19	.2	66.4
2	88.7	10.6	.6	2.39	.32	19	.2	66.4
3	88.4	11.0	.6	2.71	.24	19	.2	70.0
4	88.4	11.0	.6	2.39	.28	19	.2	70.0
5	89.1	10.6	.3	2.62	.25	19	.2	68.15
6	89.1	10.6	.3	2.43	.26	19	.2	68.15
7	88.4	11.0	.6	3.62	.26	19	.2	70.0
8	96.88	2.5	.65	1.56	.15	29	.3	20.75
9	97.7	1.4	.9	1.26	.19	29	.3	20.75
10	97.7	1.4	.9	1.67	.11	12	.1	17.3
11	97.7	1.4	.9	1.53	.16	12	.1	17.3
12	97.7	1.4	.9	1.45	.15	29	.3	20.8
13	97.7	1.4	.9	1.52	.3	29	.3	20.8
14	95.7	2.6	1.7	3.56	.15	31	.1	88.7
15	78.23	13.65	8.12	5.1	.56	33	.2	90.18
16	97.2	1.5	1.3	3.25	.34	33	.2	90.18
17	78.23	13.65	8.12	3.37	.43	33	.2	90.18
18	35.1	34.4	30.5	12.16	1.3	139	.4	48.4
19	35.1	34.4	30.5	13.54	1.91	139	.4	48.4
20	56.1	19.54	24.36	14.52	.98	91	2.17	35.8
21	56.1	19.54	24.36	10.07	.8	91	2.17	35.8
22	52.76	24.63	22.61	15.84	1.22	80	.4	42.4
23	75.5	15.58	8.92	2.68	.26	19	.2	37.0
L	78.2	2.5	0.7	2.39	0.24	19	0.2	35.8
M	95.7	11.0	1.7	3.56	0.30	33	-	68.2
H	97.7	34.4	30.5	15.84	1.91	139	2.17	90.2

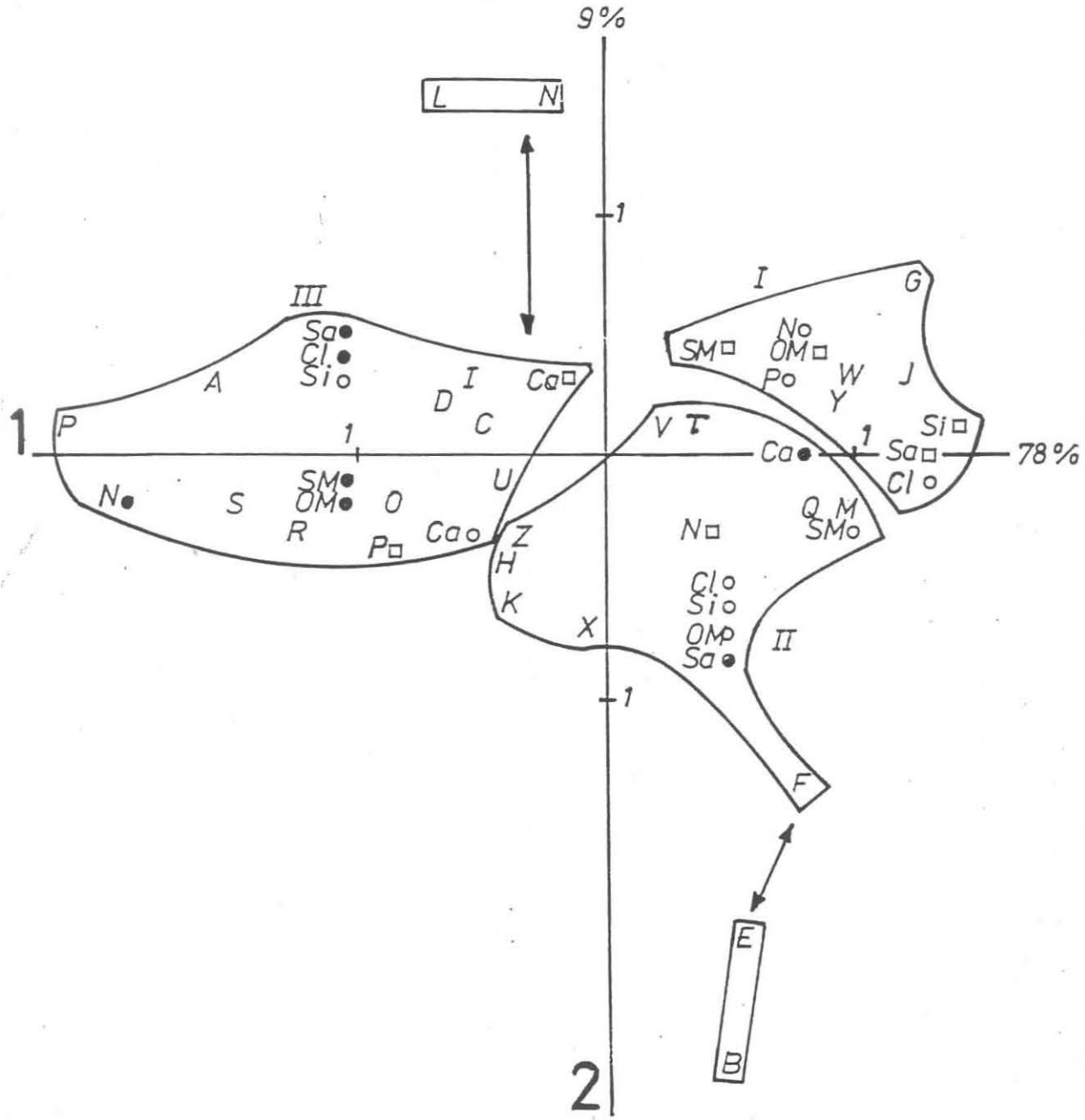


Fig. (2) Graphic representation of the application of CA and AHC methods to data of Table (1 and 2) after the application of disjunctive coding method. Symbols of species (A-Z) are as shown in Table (1) and factors are as shown in Table (2). Symbols 0□, and o followed symbols of factors are for low, medium, and higher values of these factors.□

the first axis and 9% with the second one . Three groups are separated along the first axis . These groups are:

I - Pseudoscorpions, **Scolopendra** sp., Scarabaeidae and Curculionidae which are related to medium values of silt, sand, organic matter % and soil moisture % and lower values of phosphorus, nitrogen and clay.

II- Galeodidae, ticks, Thysanura, Dictyoptera, antlions, Diptera, Lepidoptera, Carabidae and other minor orders. These groups are grouped and related with higher values of calcium carbonate and sand, medium values of nitrogen and clay and lower values of soil moisture %, silt and orgaic matter % . Snails and scorpions seem to relate to these soil characters.

III - This group comprises the rest of soil fauna groups .These groups are related with higher values of silt, clay and nitrogen, medium values of phosphorus and lower values of calcium carbonate and sand. Orthoptera and Dermaptera seem to relate to these characters.

Agricultural Habitats of Lower and Middle Egypt

Sites of agricultural habitats of lower and middle Egypt are: Mariut region (12 sites), Kafr - El Sheikh (2 sites) and Giza and Wadi Assiuty (one site each) .The habitat of Mariut region was previously described(Ghabbour and Shakir, 1981, 1982a and 1982b).

Kafr-El-Sheikh

Tadros (1974) studied the insect and mite fauna in two kinds of raw materials found in excess in almost every Egyptian farm, and especially in the Delta. These are dried rice straw and dried Egyptian clover (berseem) that occupy considerable areas of land when stored in the open in farms and storehouses, and provide unusual habitats for soil fauna. Samples were taken at Kafr-El-Sheikh, in the NW part of the Delta.

Giza

Results of two methods of extracting soil fauna from samples taken from an onion field in Giza (near Cairo), in March 1956, were published by El-Kifl (1958). This set of data represents the soil fauna of a special crop, at a special season. Sampling was by soil cores of known area and extraction by the Tullgren-funnel and flotation methods.

Wadi Assiuty

This set of data is derived from a study of soil fauna in the Wadi El-Assiuty / Wadi Habib area, 12 km E of Assiut , Middle Egypt , by a team from the University of Assiut , since 1983 .

Figs. (3) and (4) show results of the application of the CA and AHC methods to data of soil fauna populations in Lower and Middle Egypt (Table 3). 25 % of the tatal variance is associated with the first axis and 19 % with the second one (Fig. 3). Thysanoptera and Thysanura are shown to characterize the onion field in Giza, while earthworms and Orthoptera are shown to characterize the irrigated field crops at Burg-El-Arab. Spiders are shown to characterize the two extreme sites at

Table (3) Data of population density (or abundance) of soil fauna in 16 Egyptian sites . All figures are multiplied by 100 .

Taxa: .		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Coleoptera	A	1888	464	1448	790	3208	2689	5170	1784	5013	1867	5378	1969	1720	2588	1944	1730
Hymenoptera	B	0	0	7216	1086	2596	983	560	1470	515	2757	168	3378	2244	266	88	1611
Lepidoptera	C	0	0	548	25	857	341	100	92	197	53	76	0	0	0	0	341
Psocoptera	D	0	0	0	247	377	2976	0	0	0	0	0	0	0	0	0	1893
Diptera	E	0	0	226	1827	1322	1105	250	102	326	50	59	174	317	399	495	648
Tysanura	F	0	0	0	2716	0	0	30	0	0	0	0	124	8	428	381	0
Thysanoptera	G	0	0	0	2568	441	710	0	0	0	0	0	0	0	0	0	410
Neuroptera	H	0	0	23	25	0	0	0	0	0	224	273	1225	1412	0	1778	0
Scorpions	I	0	0	0	0	0	0	10	0	0	11	0	11	8	0	0	0
pseudoscorpio	J	0	0	0	0	237	123	0	0	0	0	16	37	24	0	101	148
nsearthworms	K	0	0	0	0	0	0	0	3216	2068	0	0	0	0	0	0	0
Dermaptera	L	0	27	0	0	661	61•	0	134	67	0	0	0	0	0	0	89
Orthopter	M	0	0	44	0	0	0	410	2283	0	0	0	35	31	5430	101	0
Dictyoptera	N	0	0	0	0	0	0	190	0	927	4531	2789	1123	1592	428	4354	0
Isopoda	O	0	0	0	0	2718	225	610	143	343	274	1074	39	8	0	381	133
Myriapoda	P	0	0	0	0	1706	567	0	0	0	0	31	20	6	0	0	114
snails	O	0	0	0	0	0	0	0	0	0	8	0	0	0	112	0	0
spiders	R	8112	9509	0	0	677	771	20	776	172	193	75	1227	1169	0	345	761
Galeodidae	S	0	0	0	0	0	0	10	0	0	0	0	0	0	96	0	0
Hemiptera	T	0	0	44	716	343	730	130	0	352	31	61	614	982	0	117	2842
ticks	U	0	0	0	0	0	0	20	0	0	0	0	24	72	0	0	0
other orders	V	0	0	152	0	188	369	0	0	0	0	0	0	0		0	440

Sites : 1 - rice straw, kafr - El- Sheikh, Nile Delta (Tadros 1974), 2- dried clover, ditto, 3 - wadi Habib/Wadi El - Assiuty area, near Assiut, Middle Egypt (Ali 1985), 4 - onion field at Giza, near Cairo (El - Kifl 1958), 5 - irrigated olive farm, Mariut region (Hegazi et al .1981), 6 - rain - fed olive farm, ditto, 7 - free grazing site under **Thymelaea hirsuta,** south Gharbaniat, Mariut region (Ghabbour and Shakir 1980), 8 - irrigated annual field crops, Burg - El- Arab town (Ghabbour and Shakir 1982 b) . 9 - dry farmed fig orchard, Gharbaniat (Ghabbour and Shakir1982a), 10 - free grazing site at the Omayed Biosphere Reserve, under **Anabasis articulata** (Ghabbour et al.1984), 11 - littoral sand dune site, under **Lygos raetam,** at Gharbaniat Ghabbour et al. 1977). 12 - completely protected grazing site at the Omayed Biosphere Reserve (O % grazing pressure), under **A. articlata** (Cancela Da Fonseca et al. 1984), 13 - ditto, under **T. hirsuta .** 14 - Controlled grazing site (50 % grazing pressure) under **A. articulata,** ditto 15 - ditto, under **T. hirsuta,** 16 - irrigated vineyard at south Gharbaniat, Mariut region (Hegazi et al.1981).

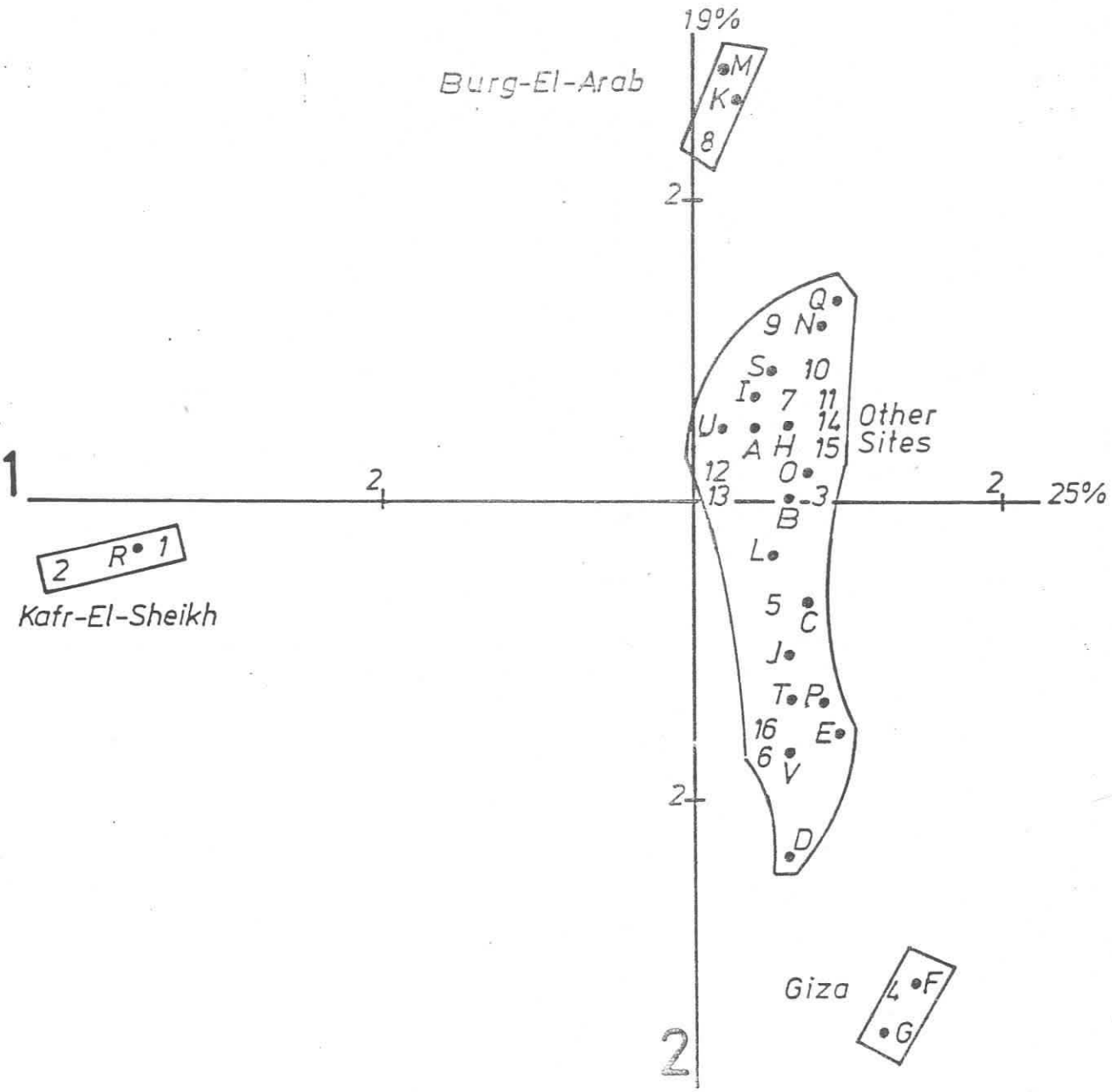


Fig (3) Graphic representation of the application of CA and AHC methods to data of Table (3). Symbols of sites (1-16) and species (A-V) are as shown in Table (3).

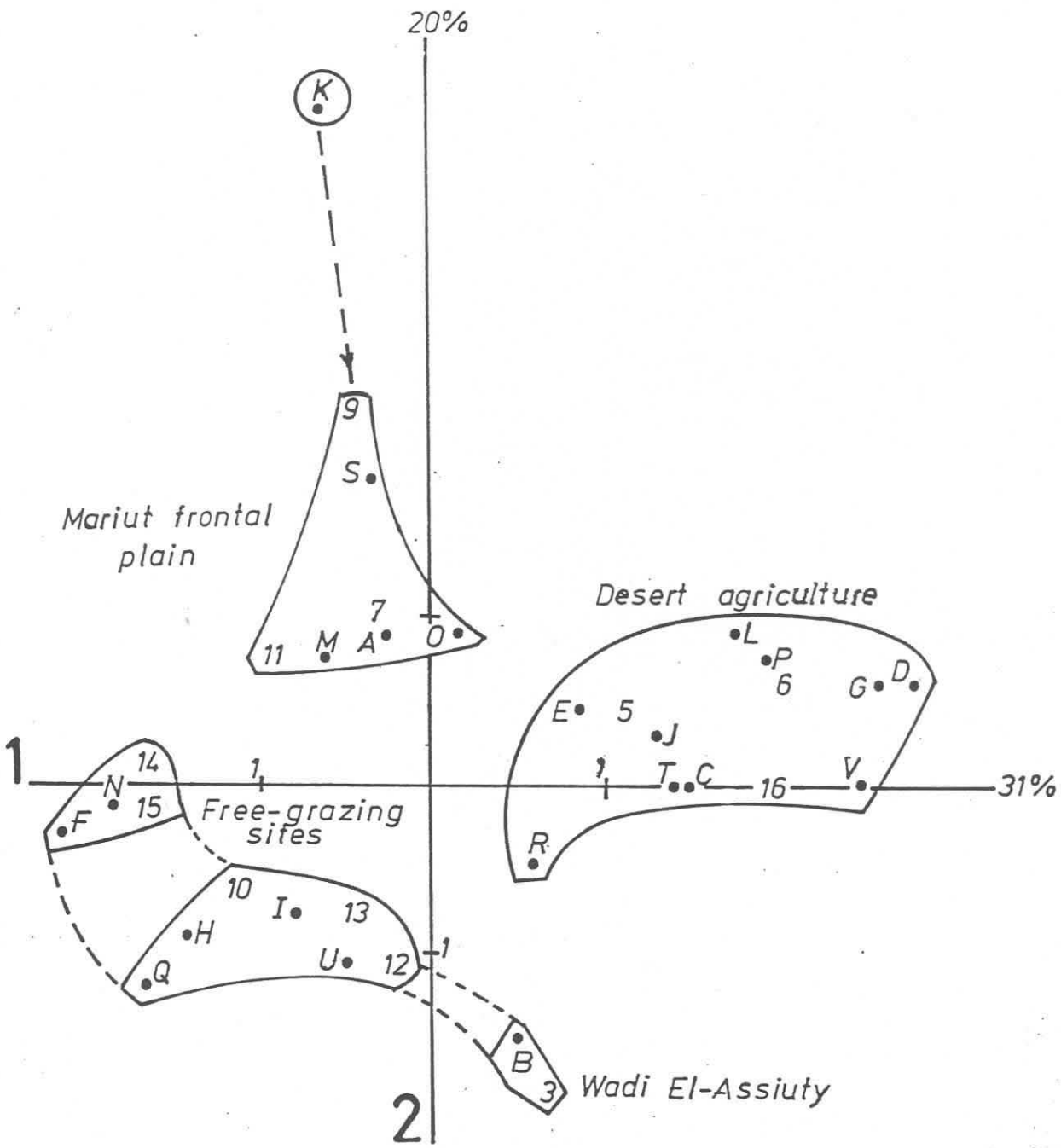


Fig. (4) Graphic representation of the application of CA and AHC methods to data of Table (3) the elimination of Burg-El-Arab, Kafr-El-Sheikh and Giza sites. Symbols of species and sites are as shown in Table (3).

Kafr-El-Sheikh: three sound cases of associations consistent with the original data. The other sites are grouped together with the remaining groups of taxa. Fig. (4) shows a second run for data of Table (3) after the elimination of the outliers Kafr-El-Sheikh, Giza and Burg- El-Arab sites . 31 % of the total variance is associated with the first axis and 20% with the second one . Classification of sites is better illustrated in Fig. (4). Sites of complete protection from grazing at Omayed, and the Wadi El-Assiuty site are grouped together and are more or less characterized by scorpions, Hymenoptera (ants), ticks, Dictyoptera, Thysanura, Neuroptera and snails. These are really ubiquitous taxa in desert situations. It is tempting therefore to consider this group of sites as reprsenting "virgin" desert almost free from human perturbations. Sites of desert agriculture are grouped together, at the right hand side of the figure, and are characterized by Hemiptera, Lepidoptera, Pseudoscorpions, Diptera, Psocoptera, Thysanoptera, Myriapoda, Dermaptera and some other minor orders. Mariut frontal plain, the littoral sand dunes at Gharbaniat and dry-farmed fig orchard are similar to each other and are characterized by Coleoptera, Orthoptera, Isopoda and Galeodidae. Earthworms are associated with the dry-farmed fig orchard, but this is regarded as only an accidental occurrence.

El-Kifl (1958) and Hegazi et al. (1981) used the Tullgren-funnel and the flotation and washing methods, to extract specimens smaller than 1 mm in length, while Hegazi et al. also used hand-sorting to extract the larger specimens, causing a "rapprochement" to the results of extractions carried out by Ghabbour and Shakir (1982 a), who used the sieving method, for the fig farm, and Ghabbour and Shakir (1982 b), using hand-sorting for the irrigated field crops farm. This might be as good example as any on the influence of extraction methods on the results of ordination. A combination of more than two methods has placed the sites investigated by Hegazi et al. (1981) in a position intermediate between those in which different methods were used but represented in the investigation of the intermediate sites.

Desert Habitats of Middle and Southern Egypt.

These habitats are represented by: Wadi Assiuty (Middle Egypt, previously described). and Wadi Allaqi, Wadi Quleib and Dihmit farm.

Wadi Allaqi/Wadi Quleib area

Wadi Allaqi is located in the Eastern Desert of Egypt between longitude 33° - 34° E and latitude 22° - 23° N about 180 km south of Aswan city. It is the major structural feature of the Eastern Desert, aligned in a NW-SE direction approximately on the junction of basement complex rocks to the NW and Nubia sandstone to the SE . The Wadi extends as far as the Sudan border and is fed by a number of tributaries from the north side and a few from the south side. Among the more extensive tributaries are Wadi Um Ashira which drain the Nubia sandstone complex. Wadi Um Arka and Wadi Hasirba are the upstream affluents of Wadi Quleib which drains part of the basement complex country.

Dihmit Farm

Dihmit farm is located about 60 km south east of Aswan city. This area is used for growing some crops such as Casuarina, Carcada and Lawsonia. Irrigation of these crops depends upon underground water.

Fig. (5) shows results of the application of CA and AHC methods to data of middle (Wadi El- Assiuty) and southern (Wadi Allaqi, Wadi Quleib and Dihmit Farm) sites of Egypt (Table 4). 85% of the total variance is associated with the first axis and 12% with the second one. Wadi El - Assiuty is separated along the first axis from sites of southern Egypt and more or less characterized by ticks, Orthoptera, antlions, Formicidae, Diptera, Lepidoptera, Carabidae, Coccinellidae, Tenebrionidae and Scarabaeidae. Sites of southern Egypt, Wadi Allaqi, Wadi Quleib and Dihmit farm are similar to each other and characterized by Spiders, Opilionidae, Scorpions, Thysanura, Dermaptera, Buprestidae and Chrysomelidae.

Fig. (6) shows results of the application of CA and AHC methods to data of the Aswan region alone: Wadi Allaqi, Wadi Quleib and Dihmit farm (Table 4). 89% of the total variance is associated with the first axis and 11% with the second one. Wadi Allaqi and Dihmit farm are similar to each other, characterized by 4 groups: spiders, Orthoptera, Dermaptera and Formicidae. Wadi Quleib is characterized by Opilionidae, Ticks, Thysanura, Diptera, Lepidoptera, Buprestidae, Chrysomelidae and Tenebrionidae.

It is noticed that 4 groups seem to be characteristic of Wadi El-Assiuty and are not present in southern Egypt sites. These groups are antlions, Carabidae, Coccinellidae and Scarabaeidae .

Habitats of Lower, Middle and Southern Egypt

Table (4) shows data of population density of soil fauna in 12 Egyptian sites. This Table comprises data about Mariut region (5 sites, previously described), Middle and Southern Egypt (4 sites, previously described), Balteem, Rafah and Fayoum.

Balteem

This is a summer resort that lies in the most northern part of the Nile Delta between the two Nile branches. Two main forms may be distinguished, the fluvio - marine flats and the coastal barrier plain and beaches (from which samples of soil fauna were taken). Soils of coastal barrier plain and beaches are sandy and the topography is basically flat with coastal dunes (15 - 25 m. high).

Rafah

Rafah city lies on the Mediterranean coast of Sinai Peninsula .The Mediterranean coastal desert of Sinai is characterized by low relief with a complex of parallel coastal dunes , with elevation of 80 to 100 m and of high permeability soils . Sampling of soil fauna was carried out in an area cultivated with peach since 1983 .

Fayoum

Fayoum depression lies in the western desert of Egypt. Samples of soil fauna were collected from an area of one feddan cultivated with cotton in 1990 at Etsa, Fayoum Governorate (Zedan et al. 1991).

Tabe (4) Data of population density of soil fauna in 12 Egyptian sites . All figures are multiplied by 100 .

Taxa:		S	A	Q	D	G	O	B	R	F	M	Y	I
earthworms	1	0	0	0	0	0	0	0	0	0	0	55	1485
snails	2	0	0	0	0	0	1	0	0	0	0	0	0
Isopoda	3	0	0	0	0	127	38	0	0	1	398	328	158
spiders	4	0	4	4	5	54	24	0	31	70	124	61	241
Opilionidae	5	0	0	1	0	0	0	0	0	0	0	0	0
scorpions	6	0	4	1	0	1	6	0	7	0	4	0	0
Galeodidae	7	0	0	0	0	0	0	0	0	0	4	0	0
Pseudoscorpions	8	0	0	0	0	7	0	0	0	0	0	2	0
ticks	9	40	0	2	0	0	0	47	0	0	12	3	0
Myriapoda	10	0	0	0	0	6	1	0	0	0	7	0	0
Thysanura	11	0	1	4	0	0	26	0	0	0	24	4	0
Orthoptera	12	23	3	1	3	0	0	0	12	7	0	4	392
sand roaches	13	0	0	0	0	980	613	690	2	0	1156	213	2
Dermaptera	14	0	0	0	1	0	0	0	0	0	0	1	19
Heteroptera	15	0	0	0	0	34	8	18	0	0	256	134	54
Homoptera	16	0	0	0	0	0	0	0	0	0	0	89	0
antlions	17	32	0	0	0	117	52	115	0	0	338	43	0
Sphecidae	18	0	0	0	0	3	5	0	0	0	0	0	0
Formicidae	19	1353	542	414	398	27	333	0	409	116	330	307	1873
Pompilidae	20	0	1	0	0	0	0	0	0	0	0	0	0
Diptera	21	393	0	10	0	36	12	0	17	5	144	55	17
Lepidoptera	22	130	10	14	1	19	12	0	10	3	60	26	65
Carabidae	23	53	0	0	0	13	59	0	0	0	130	25	85
Anthicidae	24	0	0	0	0	3	0	0	0	0	0	0	0
Coccinellidae	25	60	0	0	0	0	0	62	0	0	0	0	0
Buprestidae	26	0	3	8	0	0	0	0	0	0	0	0	0
Chrysomelidae	27	0	2	3	1	0	0	0	0	0	0	0	0
Curculionidae	28	0	0	0	0	45	17	0	0	0	0	28	0
Tenebrionidae	29	380	56	83	2	341	197	536	72	3	1542	766	217
Scarabaeidae	30	13	0	0	0	65	38	0	0	0	908	212	28

Sites : G, littoral sand dunes at Gharbaniat, 53 Km west of Alexandria, sampled by sieving method (Ghabbour et al.1985), O,free grazing non naline depression at Omayed, 81 Km w of Alexandria and about 13 km inland, sampled by sieing method (Ghabbour et al. 1985), B, littoral sand dunes at Balteem, northern Delta sandy coast, sampled by sieving method (Mikhail 1987), R, littoral sand dunes cultivated with peach at Rafah, Northern Sinai, sampled by pitfall trap method (Present study), S, Wadi Habib/Wadi El-Assiuty area, near Assiut, sampled by pitfall trap method (Ali 1985). A, Wadi Al-laqi, southeastern Aswan, sampled by pitfall trap method (in preparation), Q, Wadi Quleib, southeastern Aswan, sampledby pitfall trap method (in preparation),D, Dihmit farm, desert agriculture, southeastern Aswan, sampled by pitfall trap method (in preparation), F, cotton field treated with insecticide at Fayoum, sampled by pitfall trap method (Zedan et al. 1991), M, Mariut frontal plain, sampled by sieving method (Ghabbour et al. 1985), Y, dry-farming field crops, Mariut area, sampled by hand-sorting method (Ghabbur et al. 1985), I, irrigated field crops, Mariut area, sampled by hand-sorting method (Ghabbour et al. 1985).

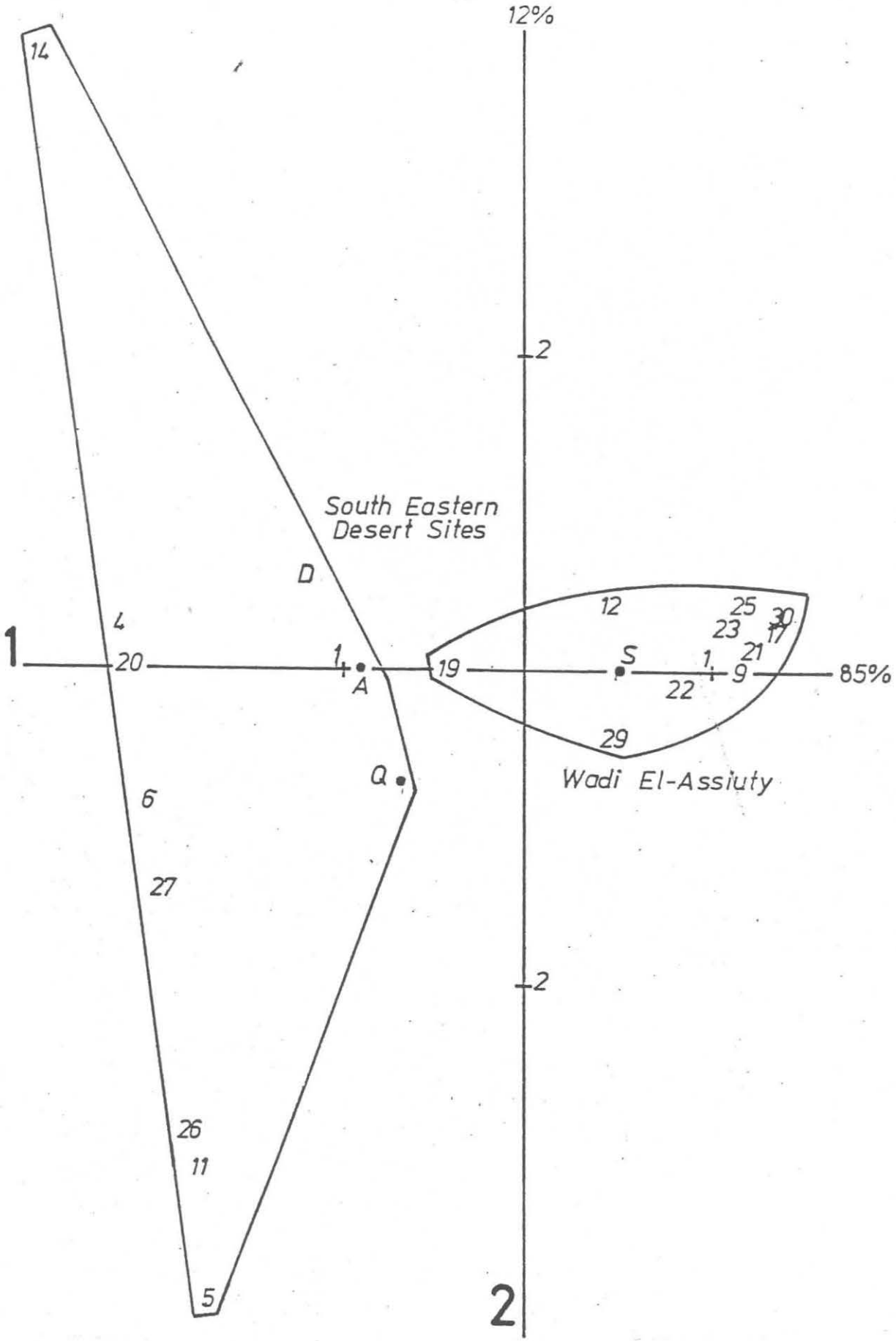


Fig. (5) Graphic representation of the application of CA and AHC methods to data of middle and South-eastern Egypt sites. Symbols of sites and species are as shown in Table (4)

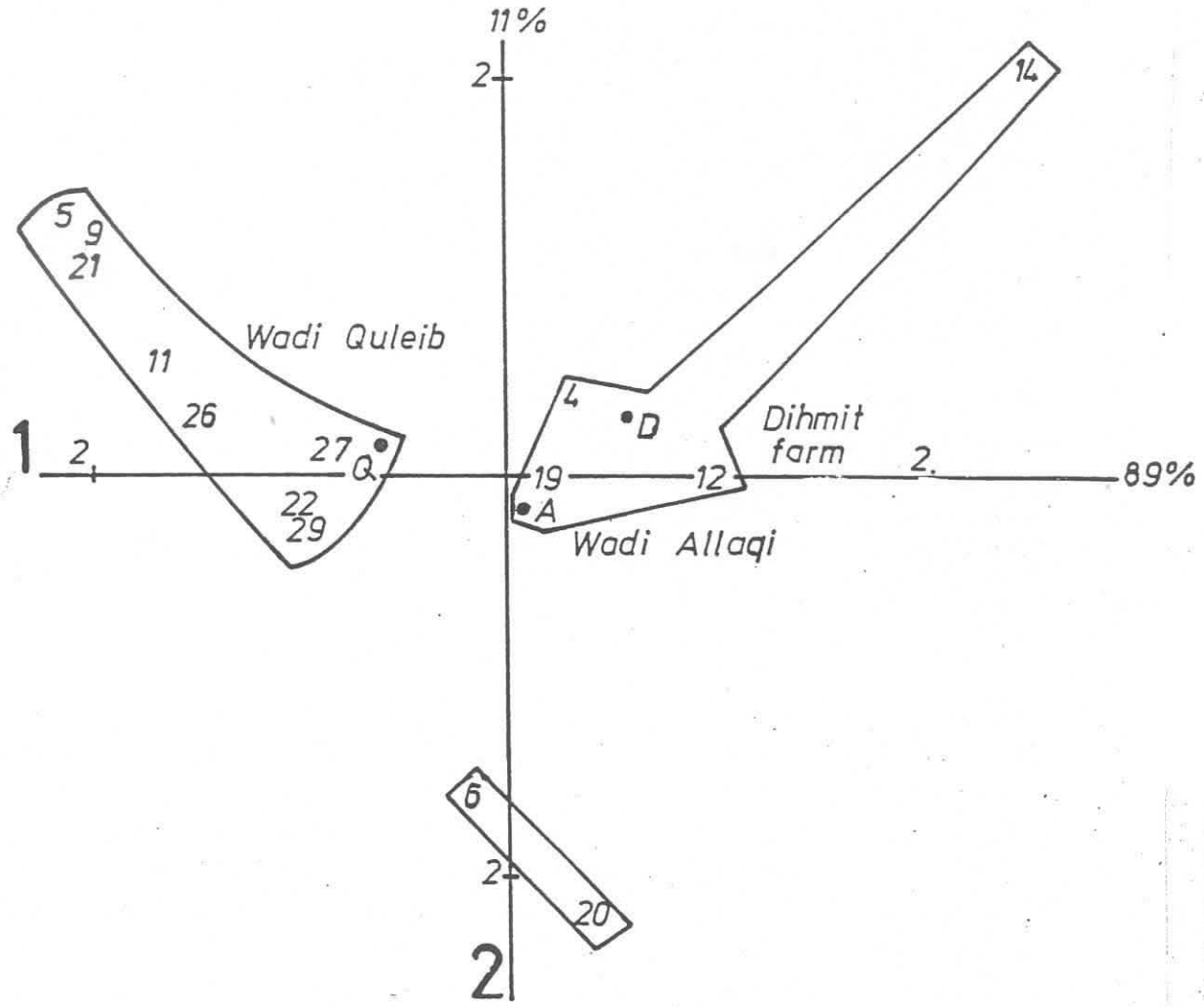


Fig. (6) Graphic representation of the application of CA and AHC methods to data of South eastern Egypt sites. Symbols of sites and species are as shown in Table (4).

Fig (7) shows results of the application of CA and AHC methods to data of Table (4). About 48% of the total variance is associated with the first axis and 21% with the second one. Generally sites of the Eastern Desert are separated along the first axis from those of the Western Desert, each with its own characteristic species. Two sites from the Western Desert, which are irrigated sites, are separated from sites of the Eastern Desert along the second axis. Rafah, Wadi El-Assiuty, Wadi Allaqi, Wadi Quleib and Dihmit Farm (Eastern Desert sites) are similar to each other and characterized by Diptera and scorpions. Four groups of soil fauna; Buprestidae, Opilionidae, Pompilidae and Chrysomelidae; are associated with the Eastern Desert sites, but are characteristic groups for Wadi Allaqi, Wadi Quleib and Dihmit Farm. Gharbaniat, Omayed, Mariut frontal plain, Balteem (sandy coast at northern Delta) and the dry farming sites of the Mariut area (Western Desert sites) are similar to each other, characterized by snails, Thysanura, Tenebrionidae, Neuroptera, Sphecidae, Galeodidae, Scarabaeidae, Homoptera, Myriapoda, Curculionidae, Heteroptera, Isopoda, pseudoscorpions and Anthicidae. Fayoum site is characterized by Lepidoptera, Formicidae and spiders. Fauna associated with irrigated field crops at Mariut are Orthoptera, Dermaptera and earthworms. Coccinellidae and ticks are considered to be characteristic of some sites of both Eastern and western desert. The proximity of Fayoum site with the Eastern Desert sites on the figure, is due to Formicidae and Lepidoptera being well represented in both areas. Carabidae are present at the middle of the Figure, and do not belong to any one site mentioned as their density is very low and are present only in the western coastal sites as well as Wadi El-Assiuty area (Table 4).

The sampling techniques affected to a great extent the pattern of distribution of these sites in the diagram and their characteristic species. All sites of the Eastern Desert happen to have been sampled by the pitfall trap method while the sites of the Western Desert were sampled by the sieving method except two of them : the rainfed site and the irrigated site of Mariut area, which were sampled by the hand-sorting method. Balteem site, at the northern Delta sandy coast, is grouped with sites of the Western Desert and was also sampled by the sieving method.

Application of ordination techniques resulted in the separation of sites of the Western Desert from those of the Eastern Desert. In order to study sites of each desert separately, the ordination technique was applied for data of Table (4) for sites of each of the Western and the Eastern Desert separately. Fig. (8) shows results of the application of CA and AHC methods to data of Western Desert sites. 47% of the total variance is associated with the first axis and 24% with the second one. The natural sites, Gharbaniat, Omayed and Balteem are separated from Mariut frontal plain and dry-farming crops sites. The Gharbaniat site is characterized by sand roaches (Dictyoptera: Polyphagidae) and antlions groups. The Omayed free-grazing site is characterized by Curculionidae, Myriapoda, Carabidae, Formicidae, Thysanura and scorpions. Balteem site is characterized by two groups, Coccinellidae and ticks. Mariut frontal plain and the dry-farming field crops are similar to each other and characterized by 12 groups . Thenebrionidae, Scarabaeidae and Galeodidae groups are more associated with Mariut frontal plain. Lepidoptera, spiders. Isopoda, Diptera, Heteroptera, Orthoptera, Dermaptera, earthworms and Homoptera groups are more associated with dry-farming field crops. Snails and Sphecidae are more associated with the Omayed site.

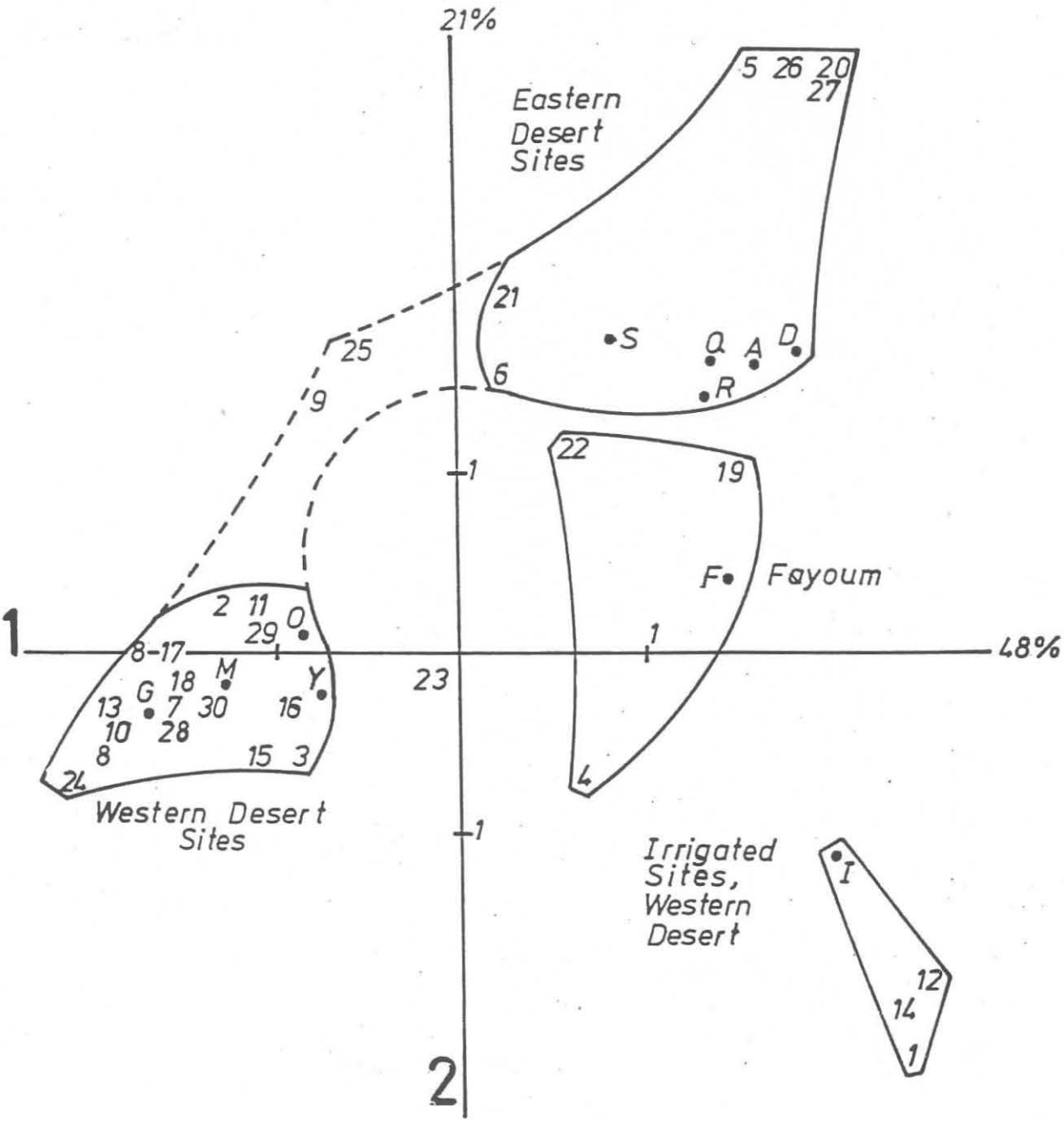


Fig. (7) Graphic representation of the application of CA and AHC methods to data of Table (4). Symbols of sites and species are as shown in Table (4).

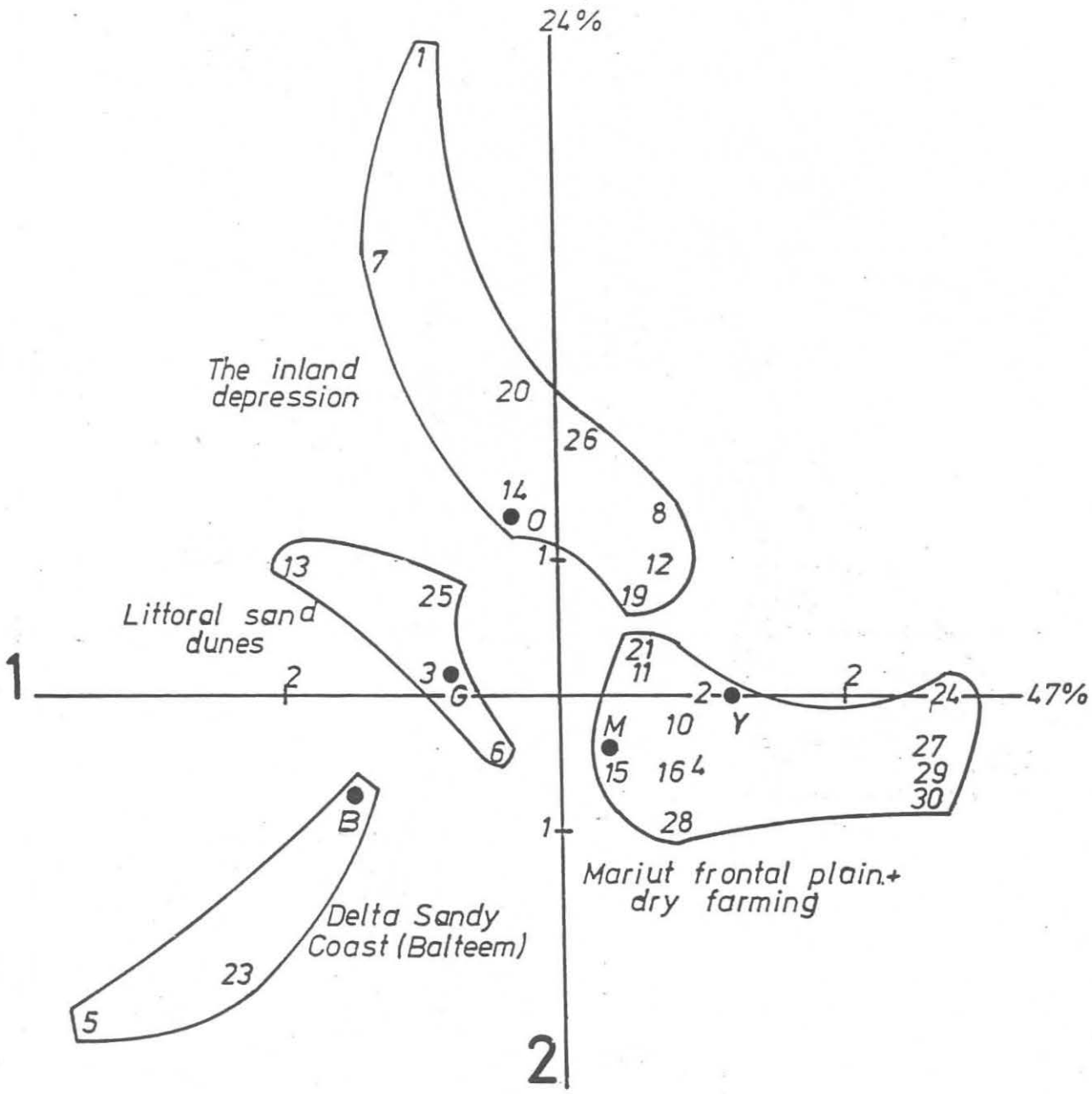


Fig. (8) Graphic representation of the application of CA and AHC methods to data of the western desert sites. Symbols of sites and species are as shown in Table (4).

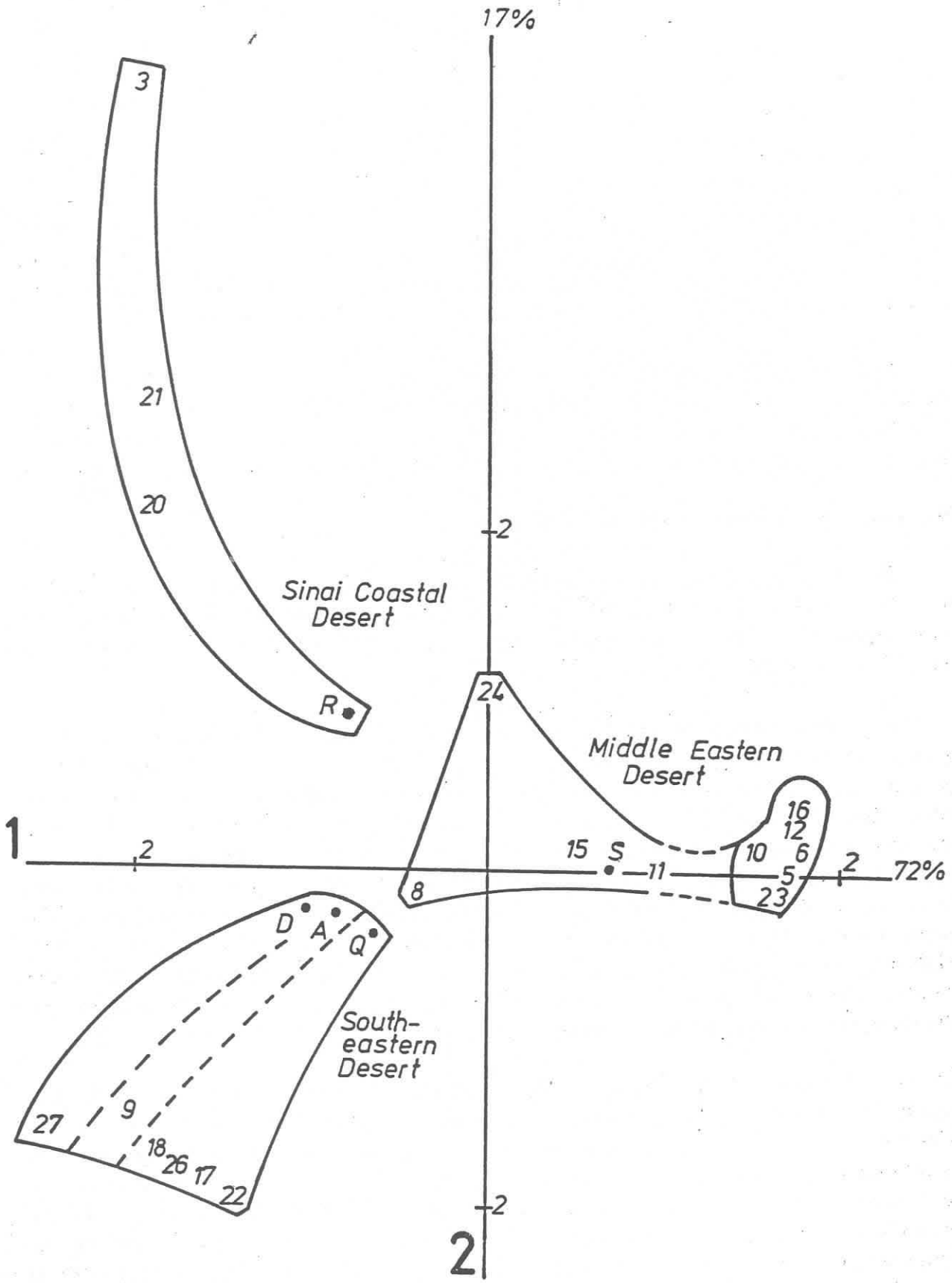


Fig. (9) Graphic representation of the application of CA and AHC methods to data of the eastern desert sites. Symbols of sites and species are as shown in Table (4).

Fig. (9) shows results of the application of CA and AHC methods to data of the Eastern Desert sites. 72% of the total variance is associated with the first axis and 17% with the second one. It is clearly noticed from the Figure that sites are arranged on geographical basis. Rafah, the Mediterranean coastal site of Northern Sinai is present at higher position in the figure and characterized by scorpions, spiders and sand roaches . The Assiut site (Middle Egypt) lies at middle position in the Figure between Rafah site and Aswan sites (southern Egypt). Assiut site is characterized by Lepidoptera, Tenebrionidae, Formicidae and Orthoptera. Another group of six taxa is more associated with this site. These taxa are ticks, Diptera, Coccinellidae, antlions, Carabidae and Scarabaeidae. The Aswan sites, Allaqi, Quleib and Dihmit, are characterized by 6 groups. Buprestidae, Chrysomelidae, Opilionidae and Thysanura are more associated with Wadi Quleib. Pompilidae are more associated with Wadi Allaqi and Dermaptera with Dihmit.

It is noticed that 4 groups were absent from the Western Desert sites. These are Pompilidae, Buprestidae, Chrysomelidae and Opilionidae. On the other hand, 9 groups were absent from the Eastern Desert sites. These are snails, Isopoda, Heteroptera, Sphecidae, Anthicidae, Curculionidae, Myriapoda, Pseudoscorpions, Galeodidae, earthworms, and Homoptera.

Nematoda in Habitats of the Nile Delta

The plant-parasitic nematodes associated with leguminous crops from five Governorates in the "old" agricultural lands of the Nile Delta were studied by Abd El-Massih et al. (1982).These Governorates are: Beheira (western Delta), Sharqiya (eastern Delta), Qaliubiya, Menoufiya and Kafr-El-Sheikh (middle Delta).

The population densities (Table 5) are presented without specifying the leguminous crops in question, from each Governorate. Nine genera of nematodes were collected, of which five were present in all five Governorates. Fig. (10) shows results of the application of CA and AHC methods to data of Table (5). 59 % of the total variance is associated with the first axis and 22% with the second one. The graph shows with reliable certainty that the five Governorates can be divided, as far as these nematodes are concerned, into two distinct groups. The first group (at left hand side of the graph), consists of Beheira and Sharqiya. the second group (at right hand side of the graph), consists of Qaliubiya, Menoufiya, and Kafr-El-Sheikh. The first group is characterized by **Meloidogyne** and **Helicotylenchus**, and to a lesser extent, by **Hoplolaimus** and **Criconemoides.** The second group of Governorates is characterized by **Pratylenchus, Xiphinema, Rotylenchus**, and **Tylenchorhynchus** and to a lesser extent, by **Heterodera**.

Fig. (11) shows results of the application of CA and AHC methods to data of Table (6), after Abd El-Massih et al. (1982). 67 % of the total variance is associated with the first axis and 16% with the second one. Lupin and peanut usually grown in sandy soils, are characterized by **Criconemoides** and **Hoplolaimus** , respectively, while the kidney bean, usually grown in clay soils, is characterized by **Xiphinema**. Broad bean, cowpea, Egyptian clover, fenugreck and pea (broad bean group) are grouped together and characterized by 3 nematode species: **Meloidogyne, Tylenchorhynchus** and **Helicotylenchus. Pratylenchus, Rotylenchus** and **Heterodera** are intermediate species between the three crop groups: common bean, broad bean group and peanut. **Heterodera** is more related however, to peanut.

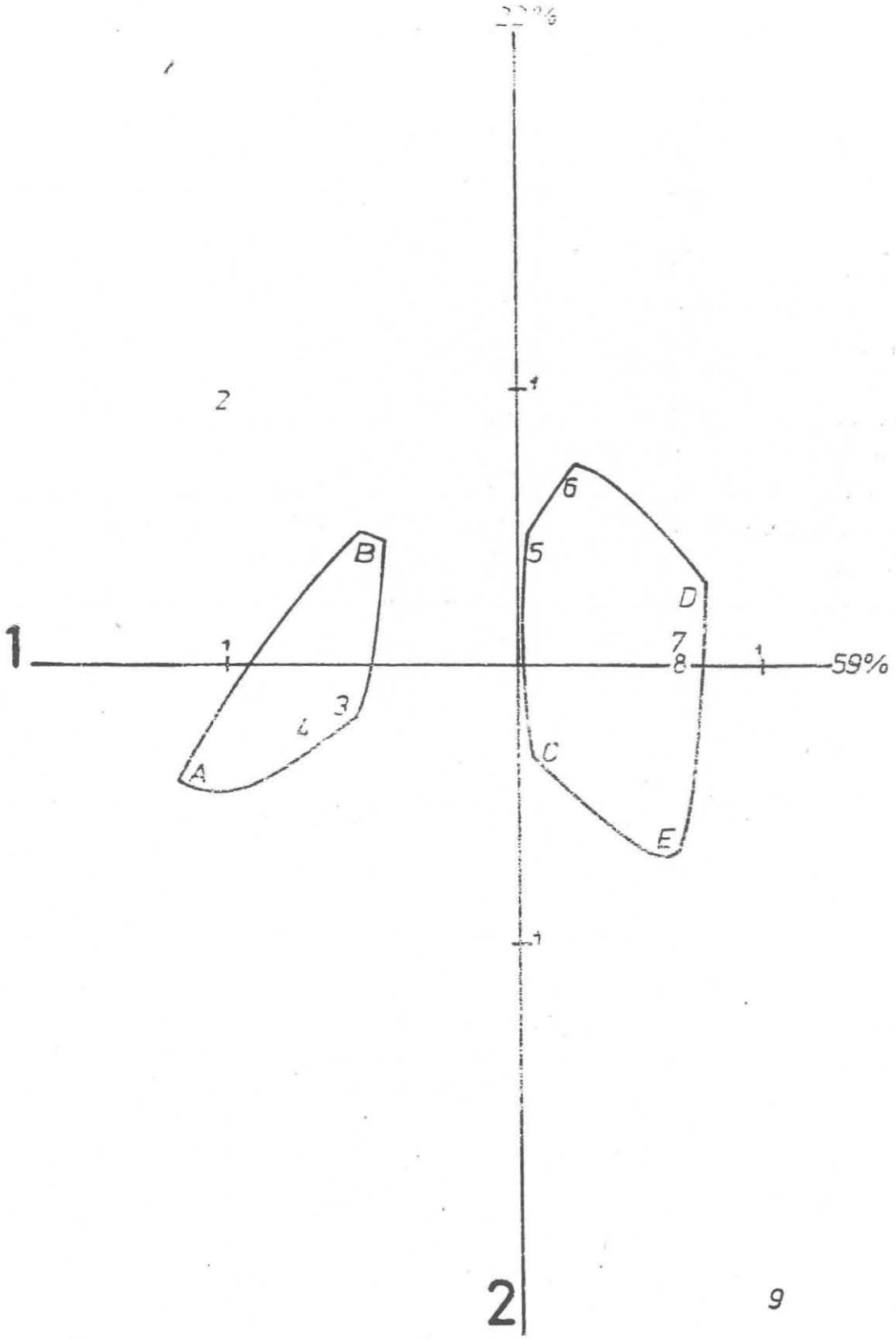


Fig. (10) Graphic representation of the application of CA and AHC methods to data of Table (5) Symbols: Sites: A, Beheira; B, Sharqiya; C, Qaliubiya; D, Menoufiya; E, Kafr-el-Sheikh Nematoda: 1, **Hoplolaimus**; 2, **Criconemoides;** 3, **Meloidogyne**; 4, **Helicotylenchus**; 5, **Pratylenchus**; 6, **Xiphinema**; 7, **Rotylenchus**; 8, **Tylenchorhynchus**; 9, **Heterodera.**

Table (5) Population density of plant-parasitic nematodes in the 5 Governorates (Abd El-Massih et al. 1982).

Nematode genera	Beheira	Kafr El Sheikh	Qaliubiya	Menoufia	Sharqia
Criconemoides	0	0	60	0	120
Helicotylenchus	310	60	540	240	420
Heterodera	0	90	120	0	0
Hoplolaimus	0	0	0	0	120
Meloidogyne	1290	600	1320	1320	1830
Pratylenchus	240	120	480	900	660
Rotylenchus	60	120	360	540	240
Tylenchorhynchus	360	1020	1800	3030	1440
Xiphinema	0	0	60	60	60

Table(6) Population density of plant-parasitic nematodes in the surveyed leguminous crops.

Nematode genera	1	2	3	4	5	6	7	8
Criconemoides	120	0	0	60	60	0	0	0
Helicotylenchus	300	0	270	780	0	120	0	120
Heterodera	0	0	0	210	0	0	0	0
Hoplolaimus	0	0	0	180	0	0	0	120
Meloidogyne	1380	0	1650	1080	210	300	300	120
Pratylenchus	720	840	0	510	0	0	60	0
Rotylenchus	0	360	300	660	0	0	150	120
Tylenchorhynchus	2310	0	1740	1860	90	270	210	180
Xiphinema	0	960	0	60	0	0	0	60

1, broad bean; 2, kidney bean; 3, cowpea; 4, Egyptian clover; 5, Egyptian lupine 6, fenugreck; 7, pea; 8, peanut

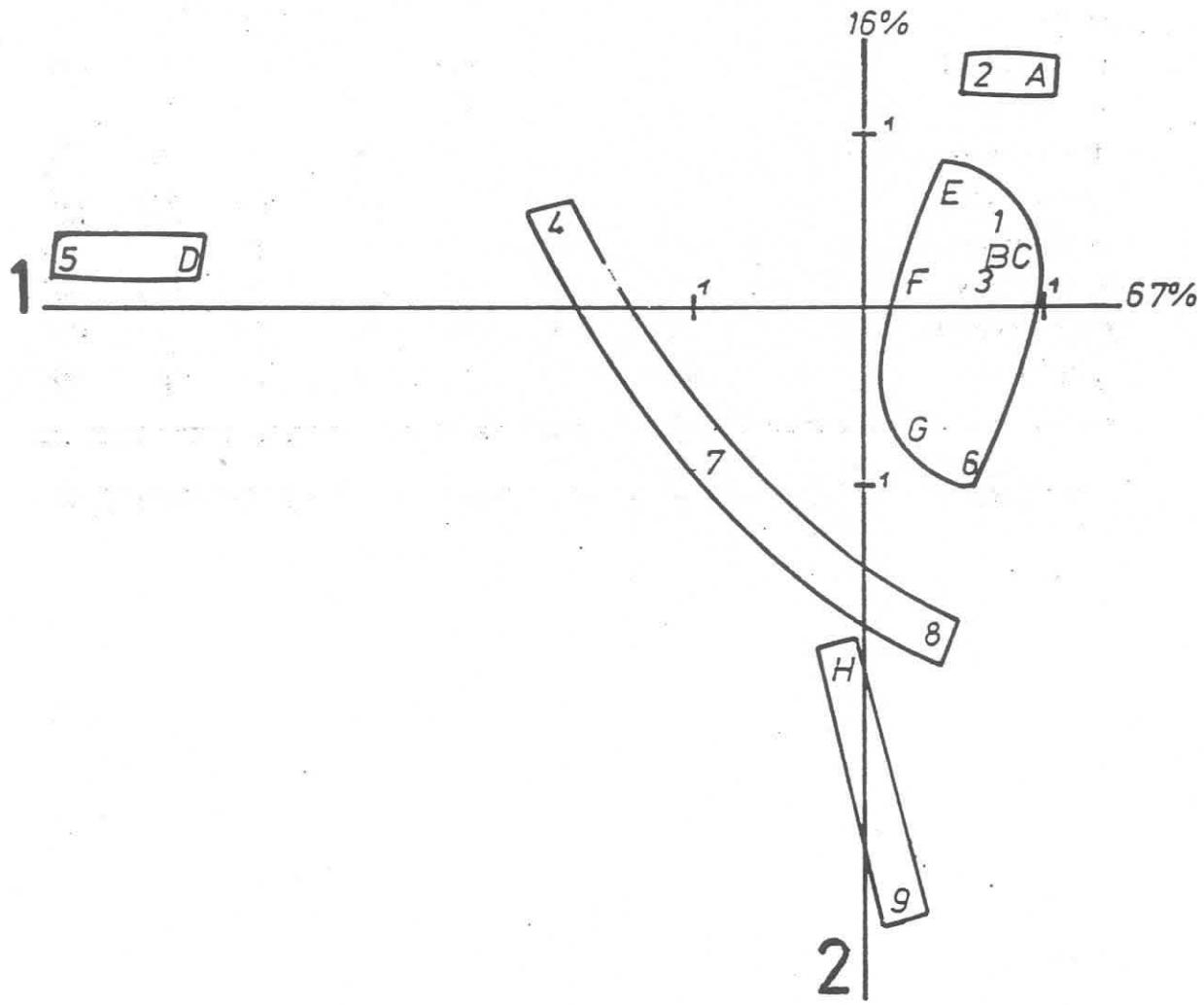


Fig. (11) Graphic representation of the application of CA and AHC methods to data of Table (6) Symbols: Leguminous crops: A, lupine; B, cowpea; C, fenugreck; D, common bean (kidney bean); E, broad bean; F, peas; G, barseem; H, groundnuts. Nematoda: 1, **Meloidogyne**; 2, **Criconemoides**; 3, **Tylenchorhynchus**; 4, **Pratylenchus**; 5, **Xiphinema**; 6, **Helicotylenchus**; 7, **Rotylenchus**; 8, **Heterodera**; 9, **Hoplolaimus.**

DISCUSSION

On the whole, the quantitative data on populations of soil fauna selected for the present study belong to sites representing a wide range of land use, both ecologically and geographically, they range from practically ungrazed littoral dunes under an attenuated xero-Mediterranean climate (Gharbaniat, Balteem and Rafah), to freely grazed area of a xero-Mediterranean desert with accentuated climate (Omayed), to completely protected desert plots at Omayed, to dry farming sites with varying degrees of human interference, to irrigated annual and tree crops in the Mariut desert, to an almost rainless desert wadi in Middle Egypt (Wadi Assiuty), to the extermely arid wadis in southern Egypt (Aswan Area), to an onion field in the "old" Nile Valley lands, to the extreme cases of dried rice straw and clover at Kafr-El Sheikh, in the Nile Delta, fields of leguminous crops in the Delta, onion at Giza and cotton in Fayoum.

Sampling was by sieving, soil cores of different sizes, and digging and hand-sorting. Extraction was also by several different methods. Units of expression were different (individual per m^2 or per pitfall trap), and so were the level of taxonomic identification, as well as frequency and dates of sampling. It can thus be confidently stated that the set of data used here could well be a good sample representing the overall set of data that could be treated for an even greater variety of situations, whether from Egypt alone, or from a number of countries with greater variability in situations .

The ordination method used in the present study (correspondence analysis) gave evidence of the main characteristic taxa of soil fauna of the sites that were tested, thus indicating either the species that better characterize the sites, or the sites in which the species are to be found with higher probability than elsewhere. In order to enhance the interpretation of the results of the analysis, it is recommended to use the Benzecri's school method of the contribution of the variables (sites vs. species) for the characterization of the factorial axes of the ordination, which allows us to confirm the indicated relationship. A second method to be applied is ascending hierarchic classification, following and applied to the result of the ordination, to show the main groupings (relations), or clusters, of the sites, in relation to their characteristic faunas.

The indication given by ordination and classification techniques, relating groups of soil fauna to land use types characterizing sites and habitats, is well illustrated from the Mariut case. In this case classification of sites based on soil fauna populations, separates between different types of land use. One can notice that the natural sites (littoral sand dunes), free-grazing sites, dry-farming sites and irrigated field crops are separated by these techniques with their characterizing groups of soil fauna (as shown in Fig. 1). Studying the relationships between groups of soil fauna and some of the environmental factors prevailing in this area (Fig . 2), confirms these results. It was found that groups of soil animals that have vertical distribution rather than horizontal (or surface- active) are associated with littoral sand dunes of loose soils and characterized by medium values of silt, sand, organic matter % and soil moisture %. **Scolopendra** (a centipede), pseudoscorpions, antlions and sand roaches are among these groups. On the other hand, the free-grazing sites are characterized by groups of lower capability of burrowing and seem to be rather surface active soil fauna. Soils of the free-grazing sites are compacted due to trampling by domestic animals. This phenomenon extends to rain-fed sites. The irrigated sites characterized by higher values of silt and clay are also characterized by Orthoptera (agricultural pests), Dermaptera and earthworms introduced to these areas as a result of irrigation by Nile water.

This is clear also in the case of plant parasitic nematodes (Figs 10 and 11). It is to be noted that Beheira (western Delta) and Sharqiya (eastern Delta), although separated by the Governorates of the middle Delta, (which constitute the second group), are highly similar, almost identical, in their nematode fauna (the plant parasitic nematodes associated with leguminous crops). This shows that this group of nematodes, characteristic of Beheira and Sharqiya, are those that are especially favoured by loamy soils, where Nil silt (and clay) is admixtured with some desert sands. On the other hand, the Governorates of the middle Delta, may be said to be characterized by a group of nematodes that should be considered as favoured by heavy clay soils, which are the type of soils prevailing in these Governorates. Accordingly, it is possible to conclude that plant-parasitic nematodes associated with leguminous crops in the Nile Delta are associated with soil type rather than with the type of leguminous crop.

Table (7) shows categorization of soil fauna groups into three categories. 17 groups are characteristic of a very limited number of habitats, or only one habital (category 1), 7 groups characteristic of various habitat types (category 2) and 7 groups not particulary associated with any special habitat type and these groups are widespread (category 3). This categorization was applied to all cases excluding the case of plant parasitic nematodes in" old" agricultural lands in the Nile Delta.

Groups generally characteristic of one habitat are Pompilidae, Galeodidae, Homoptera and Anthicidae characterizing Wadi Allaqi, Mariut frontal plain, dry-farming sites and Gharbaniat respectively. Giza area is characterized by Thysanura and Thysanoptera, Omayed site is characterized by snails and Sphecidae, Wadi Quleib by Opilionidae, Buprestidae and Chrysomelidae. Irrigated sites of the Mediterranean coastal zone are characterized by earthworms and Orthoptera (sampled with the hand-sorting method) and pseudoscorpions and Psocoptera (sampled with pitfall trap method). Groups generally characteristic for 2 habitats are Dermaptera (irrigated sites) and Coccinellidae (Balteem and Assiut). Ubiquitous groups are Tenebrionidae and Formicidae (ants), which are known as characteristic of desert habitats in general. The present study reveals the more specific characters of various desert habitats (from semi-arid to hyper-arid) and various degrees and types of human manipulations.

SUMMARY

The quantitative data on populations of soil fauna selected for the present study belong to sites representing a wide range of land use, both ecologically and geographically, from the northern coastal desert, to a rainless wadi in Middle Egypt, to the extremely arid wadis in southern Egypt. Data were treated by multivariate statistical methods such as correspondence analysis and ascending hierarchic classification. Groups of soil fauna are categorized into three categories. 17 groups are characteristic of a very limited number of habitats or only one habitat, 7 groups are characteristic of various habitat types and another 7 groups are not particularly associated with any special habitat type. Method of sampling of soil animals affects the results to a certain extent.

From this study it appears that groups of soil animals present can be used as criteria for habitat classification, together with environmental factors.

Table (7) Categorization of soil fauna groups.

Taxa	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Remarks
earthworms								+								1	
snails					+											1	
Isopoda				+			+									2	calcareoue habitats
spiders	+		+													2	more common in "old" lands
Opilionidae														+		1	
scorpions					+								+			2	open sandy-stony habitats
Galeodidae						+										1	
pseudoscorpions									+							1	
ticks					+					+		+		+		3	grazing habitats
Myriapoda																2	coastal habitats
Thysanura		+														1	
Orthoptera											+					1	
sand roaches				+		+	+			+						2	coastal habitats
Dermaptera									+						+	1	
Thysanoptera		+														1	
Homoptera							+		+							1	
Psocoptera																1	
antlions																2	open sandy habitats
Sphecidae					+											1	
Formicidae			+									+				2	more common in open sandy habitats
Pompilidae													+			1	
Diptera																3	widespread
Lepidoptera																3	widespread
Carabidae																3	widespread
Anthicidae				+												1	
Coccinellidae										+		+				2	sandy habitats
Buprestidae														+		1	
Chrysomelidae														+		1	
Curculionidae																3	widespread
Tenebrionidae																3	widespread
Scarabaeidae																3	widespread

*** Gryllotalpa sp. Sites:** A, Kafr El Sheikh; B, Giza; C, Fayoum; D, Gharbaniat; E, Omayed F, Mariut Frontal Plain; G, dry-farming; H, irrigated sites (hand-sorting); I, irrigated sites (pitfall traps); J, Balteem; K, Rafah; L, Wadi Assiuty; M, Wadi Allaqi; N, Wadi Qulei;b O, Dihmit farm; P, Category of soil animals

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